Hygienic equipment design and problematic areas in cleaning and disinfection of equipment surfaces

Wirtanen, Gun Linnea

Published in:
Eläinlääkäripäivät Luentokokoelma 2015

Publication date:
2015

Document Version
Publisher's PDF, also known as Version of record

Hygienic equipment design and problematic areas in cleaning and disinfection of equipment surfaces

Gun Wirtanen
DTU National Food Institute, Technical University of Denmark,
Kgs. Lyngby, Denmark

Extended Abstract
The general framework for food safety is given in the Regulations 178/2002 (about the general principles and requirements of the food law, the European Food Safety Authority and procedures in matters of food safety), 852/2004 (on the hygiene of foodstuffs), 853/2004 (specific hygiene rules on the hygiene of foodstuffs) and 854/2004 (specific rules for the organisation of official controls on products of animal origin intended for human consumption). The rules on both official controls performed to ensure verification of compliance with feed and food law and animal health and animal welfare rules are in force are given in the regulation 882/2004. In addition rules on materials and articles intended to come into contact with food are given in the regulation 1935/2004 and on good manufacturing practice for materials and articles intended to come into contact with food in regulation 2023/2006. The European food legislation consists of both horizontal and vertical measures, and an example of a horizontal measure is the standard of hygiene in food processing machinery SFS-EN 1672-2 + A1:2009 (Food processing machinery – Basic concepts – Part 2: Hygiene requirements). Design requirements for food equipment are given in the Directive 2006/42. Furthermore, European Hygienic Engineering & Design Group (EHEDG) has published more than 40 Guidelines, which provides practical suggestions how food production facilities, process lines and equipment should be planned, so that they are hygienic.

Hygienic site design principles are dealing with defences against both external and internal factory hazards. Detailed information on these principles can be obtained from the EHEDG Guidelines No. 44 "Hygienic design principles for food factories" published in December 2014. At the building level there should be various barriers protecting the products produced from external, environmental and non-food manufacturing activities as well as internal cleaning and maintenance activities. In hygienic factory design focus is also on the building materials for e.g. floors, walls, doors, windows, ceilings and roofs and on services e.g. electrical installations, lighting, heating, ventilation and air conditioning (HVAC) as well as production of steam and compressed air. The space for the various process lines should be reserved at the planning stage. The external and internal structures should protect the process against pests, vermin, microbes as well as foreign bodies and chemical pollution.

Common hygiene requirements for machinery used in preparing and processing food and feed must be met to maximise food safety. However, the equipment functionality and the hygienic design principles can sometimes be inconsistent. Generally compromises can be found, in case no compromises are found the functionality must be sacrificed, because non-hygienic equipment cannot be cleaned in automatic cleaning procedures. In the horizontal standard EN 1672-2 + A1:2009 there are principles, which can be applied to other machineries and equipment used in food and feed processing. Furthermore, there you can also find examples of hygiene risks with acceptable solutions. Detailed information on hygienic design of both closed and open equipment can be found in several of the EHEDG Guidelines e.g. in No. 8 on "Hygienic equipment design criteria", No. 10 on "Hygienic design of closed equipment for the processing of liquid food" and No. 13 on "Hygienic design of equipment for open processing". The minimisation of safety related risks to personnel arising from the use of the equipment are covered by the CE-mark system. Food processing equipment which are problematic to clean are conveyors, plate heat exchangers, tanks with pipelines, slicing and cutting equipment, as well as filling and packing machines. They can cause problems due to biofilms of spoilage microbes e.g. lactic acid bacteria and/or pathogens e.g. Listeria monocytogenes and Bacillus cereus.

The choice of surface materials is of great importance in designing and building facilities, process lines and process equipment for food and feed production. The process lines and equipment are easy to clean, when the surfaces are smooth and in good condition i.e. without crevices, cracks, corners and dead ends. Joints, screws, bolts, nuts, threads and also gaskets are vulnerable spots for accumulation of biofilm. Nearly all commonly used materials in food processing can support biofilm formation. Most of the adherent bacterial cells have been found in the grain boundaries of stainless steel and thus the surface structure of stainless steel is very important in avoiding build-up of biofilms. Stainless steel is the most useful material in food processing equipment, because it can be treated using e.g. mechanical grinding, lapping, electrolytical polishing or mechanical polishing to improve the surface smoothness. Experiments carried out with pathogens and spoilage microbes on elastomers and rubbers, which are used e.g. in gaskets, have shown that the cleanability of surfaces is important. These rubber and elastomer surfaces are prone to microbial growth that some of the microbes even decomposed rubber as energy sources for growth. The smoother a surfaces is and the younger a biofilm is the easier it is to eliminate the microbial colonies from the process equipment and the process lines.

Hygienic and/or aseptic systems comprise individual components, machineries, measuring and management systems and automation in production of food and feed, pharmaceuticals, cosmetics, home and water products. Systems and components are frequently put together in a way that creates places prone to build-up of microbial and allergenic hazards. Lack of information have often caused failures at different stages e.g. design, design-changes, fabrication, installation and commissioning and the failures are often caused even though there are specific design guidelines available, because these documents are not well understood. These sequencing and content errors can also result in major penalties due to delays and costs of components

and construction. The horizontal guideline 34 is about the safe hygienic integration of food production and processing equipment in the process line. This document examines integration aspects affecting hygienic design, installation, operation, automation, cleaning and maintenance. System flow charts and case studies describing the integration processes and decision steps are used. It does not provide detailed guidance on specific manufacturing processes, products, buildings or equipment. In Figure 6 there are values for minimum clearance under and between equipment or from the wall for cleaning and maintenance purposes: 20 cm clearance for equipment under 90 cm, 30 cm clearance for equipment of 90–150 cm size, 45 cm clearance for equipment of 150–210 cm size and 60 cm clearance for equipment above 210 cm.

Improvements in hygienic design can be carried out using new materials and new techniques based e.g. on 3D printing. The 3D-printing can be used to an affordable price both in planning new, hygienic process solutions and also in making new copies of nozzles, which are hard to keep clean. In 3D-printing good quality materials must be used to achieve hygienic items. The biofilm growth on surface can also be reduced by using new nanomaterials in which e.g. silver or copper has been incorporated. The major issue with these materials is that they must be properly studied to show that they are safe to use in food processing. In improving the process hygiene ultrasonication can be used for cleaning difficult constructions in conveyor belts, dry-ice cleaning for heavily soiled surfaces and both ozone and UVC-irradiation treatments for air quality.

Literature

DS/EN 1672-2 + A1. Food processing machinery – Basic concepts – Part 2: Hygiene requirements. 4. edition. Charlottenlund: Danish Standard; 2009.

EC [homepage on internet]. Brussels, Belgium: European Commission. [updated 2nd of February 2015]. http://ec.europa.eu/ enterprise/policies/single-market-goods/cemarking/.

EHEDG [homepage on internet]. Frankfurt/Main, Germany: European Hygienic Engineering & Design Group. [read in July 2015]. http://www.ehedg.org/ ® Guidelines.

Eur-Lex [homepage on internet]. Brussels, Belgium: European Union. [read in July 2015]. http://eur-lex.europa.eu/.

Lelieveld HLM, Holah J, Napper D, eds. Hygiene in food processing, Principles and practices. 2. edition. Cambridge: Woodhead Publishing Limited; 2014.